Intelligent Patrolling
HUANFA CHEN & SARAH WISE

Big Data and Intelligent Policing
CPC Project Closing Workshop
7th June 2016
Intelligent Patrolling

• Patrolling: Crime prevention & response to calls for service
• To understand how officers create guardianship and coverage
  • For strategic officers
  • Agent-based model of police tasking and movement
• To aid the route planning of police patrol
  • For front-line officers
  • Real-time cooperative police patrol routing strategy
AGENT-BASED MODEL OF POLICING
From Agents to Guardianship

**Individual Level**

Police Vehicles

*Roles, Behaviours, Movements, Interactions...*

**Macro Level**

GUARDIANSHIP

*Coverage, Visibility, Presence...*
Vehicle (Agent) Behaviours

- One of three different roles:
  - **Response Car**: nearest available vehicle attends to urgent calls for service
  - **Report Car**: nearest available vehicle attends to non-urgent calls for service
  - **Transport Van**: cooperates with Response Cars which have acquired suspects for transport, meeting and returning suspect to a station

- Begin shift at station; return to station at end of shift
- Patrol by randomly picking a point and moving towards it
Response Car Role

Patrol

Despatched to incident?

Yes
- Go to incident site (ignore traffic laws)
- Deal with incident

No

Need to make a report?

Yes
- Return to station to make a report

No

Need Transport Vehicle?

Yes
- Wait until Transport Vehicle arrives

No
The movie first shows officer movement, then the road network relative to how recently road segments have been visited. Black circles are police stations, different shades of blues represent different officer roles. The heatmap of road usage patterns.
REAL-TIME POLICE PATROL ROUTING STRATEGY
Hotspot Patrolling

- Objective: cover hotspots effectively
- Gap: Lacking detailed routing strategy
- How to design a good police patrol routing strategy?
Bayesian Ant-based Patrolling Strategy

Pheromone

... Food source

Crime Hotspot

Patrolling history, Distance, Teammates, ....

○ Pheromone (to mark the routes or visits)
Case Study

- **Agent-based simulation**
- **Hotspots map**
  - Top 5% segments with highest crime density (count/length)
- **Total patrol units**: 12-48 (two patrollers per unit)
- **Patrol Strategies**
  - BAPS
  - CCPS (cyclic strategy)

---

Camden Borough (2011.03.01 - 2012.03.31)
Measures - Example

Idleness (of hotspots): the time lag between two consecutive visits

<table>
<thead>
<tr>
<th></th>
<th>Average Idleness</th>
<th>Global Average Idleness</th>
<th>Standard Deviation of Idleness</th>
<th>ASdIdl</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.8</td>
<td>2.35</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>2.25</td>
<td></td>
<td>0.43</td>
<td>0.28</td>
</tr>
<tr>
<td>C</td>
<td>3</td>
<td></td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
## Measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency</td>
<td>To cover hotspots fairly and regularly</td>
</tr>
<tr>
<td>Unpredictability</td>
<td>To prevent offenders from being familiar with the patrol routes</td>
</tr>
<tr>
<td>Flexibility</td>
<td>To highlight hotspots with higher priority</td>
</tr>
<tr>
<td>Scalability</td>
<td>Applicable to different team size &amp; environment</td>
</tr>
<tr>
<td>Robustness</td>
<td>To remain effective in emergency response</td>
</tr>
</tbody>
</table>
Efficiency

- Objective: to cover hotspots fairly and regularly
- Measure: global average idleness. (Low GAI means high efficiency)
• BAPS has lower GAI and higher efficiency with different number of patrollers.
Unpredictability

- Objective: To prevent offenders from being familiar with the patrol routes.
- Measure: average standard deviation of idleness (ASdIdl)
- The high ASdIdl value means high unpredictability.

*Higher ASdIdl*

*Lower ASdIdl*
Result - Unpredictability

- BAPS has higher ASdldl and thus higher unpredictability.
- The BAPS patrol routing strategy covers different aspects of patrol routing.
Conclusion

• **Model of Policing**
  • A bottom-up approach to understand how the guardianship is created.
  • A tool for simulating the impact of changes of patrolling behaviours.

• **Real-time Patrol Routing Strategy**
  • A strategy to generate efficient patrol routes to cover crime hotspots.
  • A tool to aid the route planning of patrol operations.
Simulation Environment
Huanfa Chen  
SpaceTimeLab, CEGE, UCL  
huanfa.chen@ucl.ac.uk

Sarah Wise  
SpaceTimeLab & CASA, UCL  
@ComplexityWise  
s.wise@ucl.ac.uk